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INTRODUCTORY NOTE

In their Resolution on Science policy of March, 1958 the Government of India recognised the fact that the key to national prosperity lies in the cultivation of science and the effective utilisation of the human and material resources of the country through industrialisation These broad objectives can be realised only through good education in science at all levels, from the Primary School to the University This is a huge task The National Institute of Sciences of India, therefore decided some time ago to hold a symposium on the Teaching of Science At first, it was proposed to confine the symposium to Science Education in Schools only, but afterwards it was decided to include the teaching of science at the university stage as well It is gratifying to report that some of the well known scientists in the country are participating in the symposium The abstracts of the papers received up to the 25th of April, 1959, are printed in this brochure It is hoped that the present symposium will help to focus attention on the weaknesses of our present system of science education and to improve the methods of teaching science in our schools as well as colleges

CHANDIGARH,
April 25, 1959.

A. C Joshi
(Convener)

After Independence, Everyday Science or General Science has been included in the curriculum of primary and middle (Junior Secondary) classes in most of the States and graded syllabi have been framed by the State Education Departments The majority of the teachers, however who teach science to these classes have never had any instruction in science, either in their school or during their pedagogic training in a Normal or Basic Teachers' Training institution They are, therefore, not in a position to teach science In order to assure even a moderately good teaching of science at the elementary level, it is necessary that the teachers should learn General Science either in their schools or during their period of training as teachers at least up to the standard suggested for the Higher Secondary Examination This measure has been adopted from 1957 in the Punjab, where content courses in General Science and Social Studies have been made an integral part of the curriculum of the two years' pedagogic training of would be teachers of elementary schools It is essential that a similar step should be taken by other States in the country Further, the teachers of the primary and middle classes should receive training in improvising simple instruments required for teaching science to the elementary classes That is necessary for several reasons Such training can be given only during pedagogic education

teachers to make full use of the instruments that they have

The teaching of science and development of scientific attitude among the school students through science clubs has not received much attention, though initial steps in promoting science clubs in high schools have been taken during the last two years through the financial assistance given by the All India Council of Secondary Education We have as yet no scheme either for locating talent for science in the schools or any facilities for the full development of such talent

Suggestive syllabi for General Science as well as for other science subjects like Physics, Chemistry and Biology have been prepared by the All India Council of Secondary Education These syllabi are pretty detailed and give guidance to teachers with regard to experiments, etc , which the students should perform Many School Boards, however, have not yet adopted these syllabi Further, when science is developing so fast as at present there should be a permanent body constantly to review the syllabi and give directions for the teaching of science This task cannot be done merely through committees or conferences meeting for a few days

The Secondary Education Commission recommended the compulsory teaching of General Science in all high and higher secondary schools in the country. To implement the decision science teachers are required in large numbers This can be achieved only

In the high schools and higher secondary schools, *it will be impossible to have trained M Sc's for a long time to come* The country will have to manage its higher secondary instruction in science mostly through B Sc., B.T.'s/B Ed.'s. New science courses are being introduced in the high schools in connection with the scheme to raise high schools to the higher secondary level and the development of multi-purpose schools Many of the old science teachers, however, have forgotten what they acquired during their college days and are unable to perform experiments required for the new courses Workshops on large scales for the science teachers already in service are necessary to refresh their knowledge

Science education in high schools suffers a great deal from the lack of accurate science instruments Fairly large grants are being given by the Central and State Governments for science equipment The total production of science instruments in the country is much less than the sanctioned grants As the import of science instruments from foreign countries is restricted, the grants are not properly utilised and quite a good deal of money is wasted on instruments of poor quality.

Many teachers hesitate to use the instruments for experiments even if they have them in their laboratories as they are afraid of breaking them A State Service for repair of instruments can be very helpful in overcoming this hesitation on the part of

teachers to make full use of the instruments that they have

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by having special courses.

An All India Science Teachers' Association was established three years ago and has already done good work in stimulating the interest of science teachers in the improvement of instruction through its annual conferences and its quarterly journal, the *Vigyan Shikshak*. Its activities, however, need to be greatly augmented.

2. A C. Banerji, *Calcutta.*

I. The need of Science education in our country—

(a) As a part of general education.

(b) As specialised training.

II. The teaching of Science in our schools—

(a) Its purpose :—

(i) To give a good grounding for general education.

(ii) To pick up promising young children having special aptitude for science and give them proper training, so that they may become in future good teachers of science, or good researchers in science or may apply science to various purposes useful and beneficial to life.

(b) What to teach :—

(i) To give a clear idea of what science is for children—not mere study of pieces

of different branches of science but study of problems that crop up in inquisitive children's minds as they live and grow up.

(ii) To teach generalisations which would enable pupils to interpret problems occurring in their environments

(c) *How to teach* —

(i) To have proper teachers who would be able to give intelligent guidance to the pupils

(ii) To give satisfying answers to questions asked by young children, so that their curiosity and enthusiasm are aroused The answers should not be too technical Formulas, detailed explanations, and technical terms may be given at later stage

(iii) To learn carefully 'experimenting' by simple proces es

(iv) To develop the art of 'observing'

(v) To cultivate the art of 'reading' and to differentiate between facts and fancy in their reading

(d) Instructions to teachers —

(i) To decide what the teachers hope to achieve by teaching science

by having special courses.

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(i) To give a clear idea of what science is for children—not mere study of pieces

(ii) A centralised Science Club or a centralised Workshop may not be advisable as such concentration is not always desirable

(g) Proper recognition of the merits of Science teachers of the schools —

(i) Encouragement of initiative of school teachers

(ii) Fostering of interest in science and the early training of a good scientist are as valuable as researches done by the scientists

(iii) Recognition of meritorious science teachers by Government and by science academies through suitable honours

(h) Suitable textbooks and laboratory manuals

(i) Provisions of supplementary aids for the teaching of Science.

(ii) Recognition of gifted students by means of awards, scholarships, etc

III. Science teaching in colleges and universities—

(a) General education in science for the students in 'Humanities' Group.

(b) Specialised Training for science students —

(i) Competent teachers

(ii) Proper textbooks and laboratory manuals

(ii) The teacher to be alert if he is on the right track and keeps to his goal.

(iii) To arrange for a nature's trail which would afford study of plants, animals, rocks etc. and their inter-relationships.

(e) Consideration of Soviet School system :—

(i) Phenomenal advances in science and technology in Soviet States.

(ii) High place given to Mathematics and Science in school curriculum beginning from the fourth grade :—

Mathematics, Physics and Chemistry are compulsory subjects. Children unable to take these courses are shifted to vocational schools

(iii) 'Talent hunt' in Science. Exceptionally gifted students are admitted into special schools managed by the universities

(iv) Criticism of Soviet system—attempt to teach higher Mathematics and Science to those not having special aptitude would result in costly waste. On the other hand, rapid progress of technology in Soviet Union speaks in favour of the Soviet school system.

(f) Science Clubs and Workshops :—

(i) Establishment of Science Clubs and Science Workshops in schools

(ii) A centralised Science Club or a centralised Workshop may not be advisable as such concentration is not always desirable

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III Science teaching in colleges and *universities*—

(a) General education in science for the students in 'Humanities' Group

(b) Specialised Training for science students —

(i) Competent teachers

(ii) Proper textbooks and laboratory manuals

(iii) Science libraries—Central and Departmental.

(iv) Research facilities.

(v) Science seminars.

(c) Well-equipped laboratories.

(d) Science clubs, Science societies and academies.

(e) Recognition of brilliant students by means of awards, scholarships, etc.

IV. Research Institutes *versus* Universities—

(a) To consider whether more valuable researches are done in the Universities or in the Research Institutes.

(b) Whether the Research Institutes should be allowed to hold classes and confer degrees

(c) To consider what facilities should be given to university teachers to carry on researches.

3 H. Spurway, *Indian Statistical Institute, Calcutta.*

It will be suggested that an improvement in teaching standards would follow if examination results in specific subjects were no longer obligatory qualifications both for entering higher educational courses, and for academic, scientific, and technical appointments. India is much less liberal than western countries in this respect, where it is common to change

the subject of study, at least in part, after every examination, complete change of faculty is not uncommon, and the highest scientific appointments and honours can be obtained by people without academic qualifications in either arts or sciences An under-developed country should be *more* and not less flexible than richer and more integrated societies, because in the former it is *more* probable that able men, through poverty or isolation, will fail to obtain a conventional education The defence of the present system that it discourages nepotism will be discussed

A relaxation of the demand for academic qualifications will release educational establishments at *every level* from the necessity of attempting to teach subjects for which they cannot afford the laboratories

Many of the courses offered at all levels are false pretences which would be literally criminal in commerce Students are not prepared for their examinations, more serious, they are taught in such a way that they find it more difficult to respond to scientific responsibility than someone who has not been perverted by such teaching Such teaching also recruits students who have the wrong aptitudes for a scientific career I have been told repeatedly by young Indians that memory is more important than imagination in science

If the economic motive for attending such courses were removed, this would put a premium on teachers competent enough both to be interesting and to complete their syllabus. It would also increase the number of teachers which an institution would be able to afford for each subject. And it would immediately liberalize the education provided. A student who has to take science Intermediate, or B Sc., and has reason to distrust the competence of any of his teachers is not in the psychological condition to be educated by his study There are many ways of evaluating the competence of an educational institution. For example any institution whose students riot in an examination might be debarred from entering candidates in that subject indefinitely. In England the competence of all teachers of candidates for B.A. and B Sc. is judged by no other criterion than the quality of their published research

Much of the money thus saved may be concentrated on the teaching for what should be regarded *unequivocally* as the Final examination whether this is the Master's degree as at present, or an Honours Bachelor's degree as envisaged, and as in the United Kingdom.

A three-year course can easily be designed that will qualify people who have not previously studied a subject to what may be called the "international" standard, provided they are selected and have had the

experience of studying any subject whatsoever in which they have been examined at an advanced level A two-year course might be possible Such a policy is the rule in England for some sciences e g Anthropology and Physiology In a country which lacks scientific personnel there is every reason why Zoology Chemistry and Physics should be taught in the same way, so as to avoid attracting unsuitable students which is the inevitable result of inadequate teaching to beginners

The practice of awarding scholarships to young people of about 18 years of age for their senior education in return for several years subsequent service as teachers in government schools was introduced in France when the proportion of literates in that country was comparable with that in contemporary India It still continues

Suggestions will be made concerning the selection of students for such advanced courses The problem is being worked on by psychologists in India and elsewhere and at least in the United Kingdom senior scientists are very pleased indeed with the students thus selected

At present in India it is very difficult for anyone with less than a Master s degree to obtain *employment* as a scientist and most non Masters have to *be clerks* or laboratory assistants when they sometimes discover that their book *learning* is so bad as to be a hindrance Therefore it is less revolutionary than it seems to cut

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in their own right, later

In Biology a crudely printed *Amoeba* is not allowed to proclaim the dawn of animal life The *spontaneous Generation or Cell from Cell only* shout it down Darwin had to wait for his conclusions 40 years, the book could easily wait till its last chapter

A committee should approve of all students' books The committee should consist of members who are (or have been) original workers, writers and teachers (all together)

6 J B S Haldane *Indian Statistical Institute, Calcutta*

I must apologize for my limited knowledge of the subject I only know about the teaching of biological sciences in the *universities*, while my own *students* have *mostly* been graduates in Mathematics, though my teaching has been mainly biological

At its best, the teaching of Botany and Zoology at *the* M Sc level is very good Where it is not, the fault lies partly with inadequate teachers, who, however, cannot be *produced* in a hurry, partly with unsatisfactory syllabi, to which I return, but very largely with administration In all British *universities known* to me the Zoology *course is a* two year course, roughly *speaking* the vertebrates are studied in one year and the invertebrates in *another (though* most students take three *years* over the *course)* In many Indian universities both vertebrates and invertebrates

down drastically the so-called science teaching up to this level In the western countries it is recognised that a linguistic and humanistic education is no hardship, and often a great asset, in a laboratory; and certainly the quality of an education is always more important than its content

4 Lt-Col S D S Greval, *Calcutta*.

The textbooks for School Final and Intermediate students have gained in size but lost in worth steadily since 1908 Small primers and textbooks were then true *shastras* of *vigyan* They were *small* books written by *big* men Through a process allied to *Natural Selection* they had come to the top and were accepted by top ranking publishers who mass-produced them and priced them very reasonably They were easy on the eye, and easy to read being not only instructive but also interesting

Today's books on the whole are jumbles of words, badly printed on cheap paper and bound in unsightly covers The figures have no spontaneous appeal, being too small and overcrowded with details The subject-matter suffers from the same flaw it is overcrowded with details For instance the *Co-efficient of Expansion*, as a discovery by the reader is not allowed to stay on the stage as a linear wonder to be admired It is loaded at once by areas and volumes. These latter should stay away and come

in their own right, later

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are studied in each year. This almost doubles the hours of work required per teacher, and it is no wonder that many teachers have little time for research or reading. I am told that the examination time table imposed by universities makes this waste of effort necessary and that similar waste occurs in other sciences.

The standards at "Inter" and B Sc levels are far lower relative to Britain Here the fault lies partly with the professors It is normal in England for the head of a department to give the 'Inter" lectures, where the students receive a general grounding, leaving more specialized topics largely to lecturers Unless he is incapable of interesting junior students, this practice seems most desirable in India

The elementary teaching in many colleges is appalling The teachers have few facilities and are grossly over-worked Students are not taught how to use a chemical balance or a burette correctly And they are totally ignorant of the meaning of much that they have learned by rote This state of affairs would be automatically remedied if elementary qualifications *in the same science* were not required for entrance to an advanced course A good grounding in Botany, Chemistry, or even Mathematics, is far more useful to an aspiring zoologist than a poor grounding in Zoology

With negligible exceptions, school science teaching is worse than useless. For it convinces boys and girls

that the essence of science is learning words and phrases to which no precise meaning is attached Only one science could be taught in schools with no laboratory equipment beyond a hand lens and a sharp knife This science is Botany It is in fact an admirable introduction to all other sciences if properly taught I would respectfully suggest that except in a tiny minority of schools no other science should be taught except as part of Mathematics or Geography, and that a serious effort should be made to see that teachers know some Botany

I now pass to research leading to a doctorate I think that in Zoology and Botany at least, it is most undesirable that students should leave India for this purpose and I suspect that this is true in other subjects If zoologists or botanists must go abroad, Japan is the country of choice The reason is two fold Doctorates are given to Indian students in Britain out of pity and the standard is lower than in several Indian universities Moreover the students are often given problems involving expensive apparatus, and demand the same on return to India In my opinion Indian scientists should go to Europe at the stage when English ones commonly go to U S A , Scandinavia etc that is to say after publishing some research so that they know where their interests lie

Finally, I consider the syllabus question The most important reform needed is in my opinion, to encourage research in topics which do not need

expensive apparatus; notably genetics of non-microscopic organisms, ecology, animal behaviour, and so on. It will be said that this is a defeatist attitude, dictated by the poverty of India. On the contrary, these subjects have only recently become part of the curriculum for degrees in Europe or U.S.A., and India has not yet caught up. I believe that in many university departments the study of living animals is impracticable owing to administrative difficulties. If, for example, one wishes to study the distribution of times of emergence of a sample of 640 tasar silk moths from their cocoons, one requires over 640 cardboard boxes, a rat-proof room, and so on. One does not know one's exact needs beforehand. It may prove easier to get a microscope costing Rs 4000 than locally-made equipment costing Rs. 400. Above all, in work on living animals or plants it is essential to be able to buy needed equipment at a few hours' notice without sanction by an administrator

The teaching of animal genetics in India is difficult because *Drosophila melanogaster* requires a cold room, and some years' research would be needed to work out the genetics of a small insect adapted to Indian summer. This could only be done by a worker who was authorized to improvise equipment as needed Just the same is true for the teaching of animal behaviour. The present administrative system encourages the waste of money and makes the prosecution of research on modern lines difficult or impossible. Until

it is changed, there is no serious future for Biology in Indian universities

6 N K Bose *Indian Museum Calcutta*

With advancing technology India has become a little more science minded than before Our schools at one time were dominated by the traditional system of education in which information was stocked in the mind information being mostly received not from one's own efforts and enquiries but from other sources This condition has not wholly left our educational world But a healthy change is noticeable, particularly after the introduction of the Basic System of Education introduced by Mahatma Gandhi This has, however, not become as general as one could desire

It is necessary that in science teaching students *should* be encouraged to record the evidence Wise teachers try to develop initiative among students instead of coaching them Children should be encouraged to observe different plants, birds and animals as well as plains mountains and rivers Teachers should accompany them and show them by example how wonderful the living world of nature is around us As he himself grows enthusiastic over the beauties of nature and as he becomes immersed in observation and experiment his enthusiasm becomes infectious and touches the heart and mind of his pupils It is only in this way that a wise teacher can help to create a truly

new world in which his pupils begin to feel that they are not being taught but they themselves are the discoverers of new knowledge.

Such an orientation of our entire educational system is indeed difficult—difficult because there might be shortage of teachers of the requisite kind and also because it might be hard to weave such a system into the pattern of existing educational organisation.

But there need not be any reason for despair Organisation always comes later. The beginning has to be made by the right kind of teachers If science teachers are encouraged to be their own selves and helped to grow initiative, observation and experiment on their own account then this new group of emancipated teachers will form the seed of a new life in the educational world. When their number grows, organisation can also change Organisation itself can never be a substitute for initiative just as ploughing in agriculture cannot take the place of the seed—both seed and ploughing are necessary

7. K. P. Basu, *Planning Commission, New Delhi.*

If the country wants to improve its material and cultural standard of life, it can only do so through the intense cultivation of science on a large scale and its application. Teaching of science in schools and at the university level plays a dominant role in

meeting the need for scientists and technologists of the right type

In the teaching of science the schools have a two-fold role to play First they have to give the necessary ground work to those who are going on to the universities colleges of technology and similar institutions with a view to make their career in some branch of science Secondly to provide a basic background knowledge of the fundamentals of science to all students since no education can now be considered complete which does not include elements of science in the same way that it includes an element of History language and of Mathematics Science *has its impact not only on the amenities of life but* also on economics commerce and industry and on our very modes of thought Much more thought has been devoted to the non scientific education of scientists than to the converse process Teaching of science should be made compulsory in all our high schools

In the majority of our higher secondary schools today teaching of science including Mathematics is hopelessly inadequate and cannot be compared with the standard of U S A U K or U S S R where in the top four classes while providing for training in scientific subjects special emphasis is laid on Physics Mathematics and Mechanics. It would be interesting to note the distribution of class-hours by categories and subjects in the last 4 years of the 10 year high

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school curriculum in the U.S.S.R. and the 12-year high school curriculum in the U.S.A. Serious effort should be made to develop in each of our higher secondary schools at least one section of 40 students where training in scientific subjects on the lines of schools in the U.S.A. and U S S R should be provided.

For the proper and efficient teaching of science in schools it is necessary to take steps so that the schools are properly supplied with graduate science teachers of good quality. There is shortage of science teachers in schools because the promise of greater material rewards lures the science graduates into administrative, industrial and other fields The conditions of service of science teachers in schools should be such as to attract really capable men to the profession. Faced with the problem of paucity of science teachers in schools, the following steps have been taken to increase the supply and quality of science teachers in U.K Their salaries have been improved. In 1938, a graduate science teacher in a grammar school got up to £ 480 per annum, in 1948 a senior science master got £ 800 a year and today he gets £ 1400 a year. The age of retirement of teachers in schools was raised in 1955 from 65 to 70. Neighbouring schools have been encouraged to share science teachers, particularly in the top-most classes Three or four years ago the Ministry of Education published a pamphlet putting the claims of teaching in schools as a career to university science graduates.

This is being supplemented by regular visits to the universities of distinguished directors of education, headmasters and science masters to put the claims of teaching to third year science under-graduates Such visits have proved quite successful

Some measures on the above lines have to be adopted in our country

While men are obviously more important than material and money and some teachers achieve excellent results with the most make shift equipment, without adequate laboratory facilities and scientific instruments the teaching of a science teacher in school becomes ineffective Immediate steps are necessary for the provision of adequate laboratory facilities and the supply of the necessary scientific instruments of the right type to schools

Greatest care should be taken in prescribing text-books containing correct information Steps may be taken to have such textbooks written in English and regional languages

An intensive programme of lectures demonstrations and exhibitions should be arranged at different centres which should help to interest young pupils in schools as well as the public in science The National Institute of Sciences may set up a Penal of Lecturers who will be available to any centre where popular lectures on any branch of science are wanted These lectures should cover all aspects of science including

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The main burden of training of future scientists and initiating them into methods of research has to be borne by the universities and it is necessary to ensure that the emoluments, research grants and other facilities available to the university teachers are adequate and in no way inferior to those available to people in similar positions in the administrative services, in national laboratories and elsewhere Incidentally, it may be mentioned that in U K while in 1938 a university lecturer rose to £ 500 per annum, a reader to £ 600 a year, the corresponding figure to day for a university lecturer is £ 1 650 and for a reader £ 2,100 The Director of a Laboratory gets about £ 3,400 a year Place of research in universities and post graduate teaching must be recognised Without research any programme of post graduate teaching will fail An essential qualification of a university teacher is that he should be capable of increasing knowledge by research

If science has become very important in modern life, modern physics has come to occupy the most dominant place in the field of science The time has come when schools of post graduate teaching and research in modern physics should be developed in at least four universities of India Each such school should have adequate number of competent professors readers and research fellows on the staff

Science is playing an increasingly important part in the day to-day lives of the students and teachers of the schools and colleges of this generation The teaching of science has been comparatively of recent origin as compared to the art subjects At the school level very little attempt has so far been made to give adequate science teaching on lines comparable with that existing in Europe and America There is no doubt that an organised attempt must now be made to evolve a system of science teaching both at the school level and at the college level to fit in with the needs and requirements of a rapidly developing country such as ours

Science teaching in schools must be strengthened The time proportion between arts and science subjects should be adequately broadened in such a way that the students mind can develop a balanced outlook on science and humanities If there is an emphasis on science over the humanities for the next 20 years of life of Indian students perhaps that would not be considered undesirable

At the school level a wide coverage of science subjects including both physico-chemical and biological sciences should be attempted Due prominence must be given to Mathematics which is the foundation of all sciences Physiology and psychology must be introduced more as part of science teaching in the school level

history and philosophy of science

The main burden of training of future scientists and initiating them into methods of research has to be borne by the universities and it is necessary to ensure that the emoluments, research grants and other facilities available to the university teachers are adequate and in no way inferior to those available to people in similar positions in the administrative services, in national laboratories and elsewhere Incidentally, it may be mentioned that in U K while in 1938 a university lecturer rose to £ 500 per annum, a reader to £ 600 a year, the corresponding figure to day for a university lecturer is £ 1,650 and for a reader £ 2,100 The Director of a Laboratory gets about £ 3,400 a year Place of research in universities and post graduate teaching must be recognised With out research any programme of post graduate teaching will fail An essential qualification of a university teacher is that he should be capable of increasing knowledge by research

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close contact between the teacher and the students should be ensured by organisation of tutorial work English should be the medium of instruction Admission to the University should be strictly confined to the really meritorious students and be limited in number Incompetents should be weeded out by an expert selection committee Quality and not quantity should be the main objective, particularly in assessing merit on the basis of research publications All unhealthy competition for recognition based on the mere quantity of research papers should be discouraged This is of particular importance in awarding degrees by research

10 N R Sen Calcutta

Every science has some distinctive traits at every stage of its development The fundamental parts of Science are not subject to varying fluctuations as are the borderlines of knowledge still they may be viewed in different lights which may be thrown down upon them from the upper regions of scientific thought Scientific instruction in our schools and colleges should take note of this and should be somewhat coloured by the tendencies of scientific thought of the time Fundamental observational facts should be firmly stressed attention should be drawn to inferences and working hypotheses and at least at the graduate stage the students should realize their significance There should be no tendency in one with instruction of this type to regard every variation of older ideas as heresy

tions from every day life In other words, this will constitute a course of every day science In the second stage comprising the IX and X classes the students will be required to obtain an elementary knowledge of any two basic sciences preferably of physics and chemistry Suitable textbooks for these two courses are to be prepared The medium of instruction should be the regional language retaining as far as practicable the internationally adopted symbols and terminologies Students should be encouraged to perform simple experiments in order that they may develop a scientific attitude of mind and be initiated into the scientific mode of thinking

In colleges the medium of instruction should preferably be English Mere acquisition of facts without assimilating the fundamental principles and generalisation involved should be discouraged Admission to colleges should be restricted to students who have given definite evidence of interest and aptitude for science in the school Too much of technological details should not be mixed up with courses of fundamental science Overcrowding should not be allowed under any circumstances and full facilities for intensive practical work should be provided

In the University where a single science subject with specialisation in any particular branch of the same constitutes the course more time should be spent in the laboratory work than for attending lectures A

close contact between the teacher and the students should be ensured by organisation of tutorial work English should be the medium of instruction Admission to the University should be strictly confined to the really meritorious students and be limited in number Incompetents should be weeded out by an expert selection committee Quality and not quantity should be the main objective particularly in assessing merit on the basis of research publications All unhealthy competition for recognition based on the mere quantity of research papers should be discouraged This is of particular importance in awarding degrees by research

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In theoretical studies attention should be paid to the logical development of the subject from natural laws and principles supplied by observational facts. Deriving of mathematical formulae for use not from fundamentals should be discouraged. This evil exists in our courses in Physics in many universities and should be energetically eradicated.

11 M R. Sahni, *Chandigarh*

The fall in educational standards is not connected mainly with fall in teaching standards, but is due to changed psychological and social environment. This has affected intrinsic interest in the finer aspects of scientific work. Were it not so, it would be inconceivable that nearly all the outstanding men of science this country has produced are the product of science teaching when the so called standards were much lower than today

Among other reasons for such deterioration are the following:

1. Lack of uniformity in syllabi and methods of examination
2. Lack of inspiring teachers or qualified men to guide research
3. Insufficient appreciation of Indian research workers, combined with preference to second rate foreign workers.
4. Lack of a suitable language policy which

has led to uncertainties regarding the future of science teaching in India, whether in Hindi or English It has also led to the production of unsuitable translations of science textbooks

5 The Science Congress has also adversely affected standards of research by publishing "Abstracts" of scientific investigations which have scarcely any value

The following measures are suggested to improve standards of science education

1 Provision of greater measure of security to students so that they are unhampered by extraneous difficulties in their day to-day life

2 Greater interest in current research by students at the graduate and post graduate level

3 Exchange of teachers by Indian Universities and exchange with foreign Universities

4 Restriction of admissions and increase of staff revised methods of recruitment of staff and review of appointments made irregularly

5 Field training in the case of the field sciences

6 Serious action against cheap note books

7 Acceptance of Ph D and D Sc theses only

if adjudged "suitable for publication in the form submitted"

8 Curtailment of the length of theses subject to certain conditions

In the case of schools he advocates

1 A museum for each school
2 Field trips for natural history study
3 Encouragement of powers of expression by means of "wall newspapers" and
4 Liaison between schools and colleges

Finally, it is necessary that those who guide the educational and technological destiny of the country should be themselves active teachers research workers men of science, not pure administrators so that they can appreciate the technical facts of various problems associated with science teaching educational standards and so on

12 C S Ghosh *University of Roorkee*

Universal education is of momentous concern in our present age, specially because of our democratic parliamentary system Education is the basis of true democracy and without it a democratic form of government might easily be overthrown The educational system has to adjust itself to the social revolution which we are in the process of undergoing Further, we must be conscious of the progress into scientific and technological times

We are not still clear about the aims of education in general and science teaching in particular There is a great divergence of opinion and practice Technologically advanced countries like U K and U S A feel that the system of education specially in the secondary state, should be reasonably flexible

In formulating any educational method we must take into consideration the calibre and standard of students who are going to be taught and their environments at home

Education in the past, from academic point of view has always been an analytic and generalising approach On the other hand there is a general sentiment of hostility or apathy among the students to read books A well provided library with generous facilities help to create the atmosphere for students to overcome this apathy and to become good readers

In regard to teaching specially science teaching in school what is needed are an atmosphere and method of teaching which shall give the students at all levels a sense of the value and excitement as the source of an attitude to life The teacher should spend much of his time making certain students forget they are in school Only after they have got interested in the subjects being taught they are to be reminded of the school set-up The best approach to this end is the attitude of informality by the teachers A teacher has to be less conventional and more and

if adjudged "suitable for publication in the form submitted".

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12 C. S Ghosh *Universal Education*

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unobtrusively, controlled and purposeful

In the Western countries, in regard to the scope of teaching, the general trend is towards a more fluid notion of the curriculum An imaginative grouping and interweaving of studies in certain subjects is essential There should be a kind of science teaching that aims rather at communicating some sense of the scientific method than at giving instruction in a particular branch of science There should be a little knot of practical subjects

On the other hand, however, successfully the teachers' interest in the subject and life has been communicated it will be found that the students long to have their work assessed as for the passing of an examination To make the best of this situation, towards the end of his school session, a student may be given a body of work that sprang out of the schools' own course of study and that was on a theme or of a nature decided by consultation between the student and his teachers Such tests should, however, remain individual and flexible The goal of education should be to persuade the students to continue their education in some way or other after they have left school

Regarding science and practical education there should be a good blending between practical and useful education on the one hand and arts and humanities on the other The approach to education should be geared to the working of the present day scientific civilisation The student should be made

more the relaxed informant and guide. The aim must be to provide as much formality as is good for a student, for the rest there has to be a sense that schooling is not a process separate and formal and rather enclosed

By paying attention to the young student—"watch him, study him constantly", said Rousseau—it is possible to psychologise and humanise learning We should attempt to relate teaching to the immediate interests of the young student By "immediate interest" is meant not only the interests he already has, it also, to a less extent, implies the need to stimulate new interests to carry him forward to unchartered reaches The teacher has to note his readiness for new interests a spontaneous yearning, a sudden impulse of the soul

A teacher must have a clear and definite idea of what basically he needs to do and to help the students to do, he must always be ready to digress to take advantage of the enthusiasm of the moment The material of teaching, specially science teaching in schools, must be taken if possible from immediate sources, for the reason that such material is not an abstract idea but an honest true to life material The teaching, at all costs, must show that education is concerned with the honest every day stuff of existence Daily incidents should be looked at in an atmosphere that, though informal instil a school atmosphere—an atmosphere of study that is, however

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to understand the social context of his work It must be remembered that the adult life of our students will be concerned not primarily with books and the past, but also with the working of our complicated scientific economy in the present.

What we want today is science graduates who can think and act for themselves, graduates who can choose between truth and falsehood, wisdom and folly, beauty and ugliness, and thus contribute, by their nature, a good society.

13 **T S Mahabale** *Poona University, Poona*

The teaching of science at different stages in the history of development of a country has to have different objectives. Mere understanding of scientific phenomena and intellectual pursuit would not be enough In the present state of development of our country, our courses need to have a strong applied bias For this purpose, sound background and comprehensive understanding of more than three or four different science subjects are essential, and to achieve this our teaching should be more objective and practical It should evoke curiosity of young minds in schools and should provide enough data at the graduate level At the post-graduate level, it should give free scope to a student for specialisation either in applied or theoretical subjects. Adequate background of theory in allied subjects alone will enable him to be useful in branches

more than one To achieve this, our courses will have to be reorientated More hobby rooms, work shops, museums reading material and better teachers have to be provided At the highest level, teaching of science tends to become personal as no utterances from pulpit can enthuse a student to pursue science for its own sake Research by example set forth by persons deeply wedded to the pursuit of science is far more effective than mere class room teaching

Our examination system should also be remodelled It should discourage cramming and encourage original thinking It should test more the ability of a student to utilize knowledge he has gained to face new situations and problems, rather than to know how far he has or has not learnt certain things from books More emphasis therefore should be put on day-to day work and that should be given credit in the examination Looking to the needs of trained personnel in science in India today, linking of science teaching with research and technology is inevitable It could be done in any language but not at the cost of standards

14 M L Bhalla *Delhi University*

Teaching science to children should be related to things immediately around the child—home, garden, fields, village or town

Some observations, primary requisite

Rain, monsoon, change in season, sky, forecast

to understand the social context of his work. It must be remembered that the adult life of our students will be concerned not primarily with books and the past, but also with the working of our complicated scientific economy in the present.

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Flowers, animals Modern inventions—telephone, telegraphs, Wireless, Radio, Television, Electric light, Hydro electric, Atomic energy Air, motor, and steam transport Factories, mills, printing press cloth mills etc

Hobby workshops with different gadgets where elements of Physics and Chemistry etc could be learnt

Garden for the study of plants, zoological garden, aquarium museum

Excursions to country farms live stock slum areas to see need for sanitation, water works, power house, and other projects

Visual aids—newsreels, cinemas

Free choice of science subjects for study

Adequately equipped laboratories, qualified teachers, proper libraries Frequent practicals, better textbooks Model laboratories in every town Refresher course for teachers, Scientific exhibitions

Boys and girls should be awakened to the frontiers of knowledge and growth of each field Is it necessary to give different scientific training to girls? Multipurpose schools

English must remain a medium for teaching science

Leading scientists should talk and demonstrate to

school students in simple language their scientific researches—(British Association for Advancement of Science, 1958)

Three years' degree course

Screening necessary, and an aptitude test essential

Final choice of subject combination at this stage. Carefully chalked out syllabus

Main and subsidiaries Tool subjects need equal attention

General education course essential Pure science course not advised More emphasis on Practicals Science Clubs

Growth of scientific ideas, discoveries, inventions and impact of science on civilization rather than lot of textbook knowledge

Honours, or Pass and M Sc should be integrated course of studies

No specialization at this stage Reform in teaching and examination systems necessary Choice of profession

15 K C Mukherji *Calcutta*

In the Higher Secondary School the laboratory courses in Physics Chemistry, Physiology, Psychology

etc have been introduced, but I feel that the informational courses in Natural Science—not overburdened by insistence on technical laboratory work to awaken interest in science may also be introduced in the Lower Secondary School work This informational course for science instruction is to be very carefully made in a way to make the pupils acquainted with the phenomena of nature which are directly valuable to the learners In the framing of the course the need of the facts or the psychological needs of the learners and their capacity should be particularly emphasised without reference to the logical need or relation of the subject-matter Individuals being biological organisms and Psychology being a phase of Biology all pupils should have some knowledge of biological and psychological facts and principles for the maintenance of their life and health So the nature of science instruction in the informational course will include the facts and principles of certain sciences which are useful for the affairs of ordinary life of average individuals

16 S C Seal *Calcutta*

For modern ways of living the importance of teaching of science in schools as a compulsory subject cannot be over-emphasised It is necessary for the purpose of moulding our younger generation to develop as good citizens and to build the proper foundation for

a useful career. Fortunately, this principle has recently been accepted by the educational authorities in the country, but the bottleneck is in the actual implementation of the scheme. *In 1956, the author urged upon* the members of the National Institute of Sciences to take active interest in the problem and to assist the Education Department with their valuable suggestion and guidance. The problems, as they stand *now*, can be *discussed* under the following heads :—

1 Planning of curriculum for *different grades* of school teaching
2 Preparation of appropriate textbooks for each grade
3 Selection of adequate number of teachers—their qualification and remuneration.
4 Methods of teaching—didactic, demonstration and practicals.
5 Provision of adequate laboratory facilities and equipments for practicals and demonstrations on various science subjects.
6 System of Examination.
7 Choice of further studies.

For the purpose of planning of curriculum the entire school career can be divided into four stages :— (1) Primary (up to class IV), (2) Upper Primary (up to class VI), (3) Secondary, and (4) *Higher Secondary*. It may be pointed out that without defining the curriculum good textbooks cannot be written, and

etc. have been introduced, but I feel that the informational courses in Natural Science—*not* overburdened by insistence on technical laboratory work to awaken interest in science may also be introduced in the Lower Secondary School work This informational course for science instruction is to be very carefully made in a way to make the pupils acquainted with the phenomena of nature which are directly valuable to the learners In the framing of the course the need of the facts or the psychological needs of the learners and their capacity should be particularly emphasised without reference to the logical need or relation of the subject-matter. Individuals being biological organisms and Psychology being a phase of Biology all pupils should have some knowledge of biological and psychological facts and principles for the maintenance of their life and health. So the nature of science instruction in the informational course will include the facts and principles of certain sciences which are useful for the affairs of ordinary life of average individuals.

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	matters—living and inanimate, preliminary basic ideas leading to study of Physics, Chemistry, Biology, etc
	(2) Hygiene & Physiology
4 *Upper Secondary*	General Science—higher grade, and elective subjects— Physics, Chemistry, Biology, etc and Physiology & Hygiene should, however continue as a compulsory subject

Care should be taken that the young brain is not overburdened with too many subjects and too much details Mathematics should, however, be a compulsory subject all through Craft should only be an additional subject Social Studies may be dovetailed with Physiology and Hygiene

In the proposed curriculum as published by the Board of Secondary Education of West Bengal a large number of mistakes and discrepancies have been noted, besides some obvious defects in the preparation of the curriculum and the syllabi All these need thorough scrutiny and revision It is therefore proposed that a Committee divided into several sub-committees may be constituted to deal with the problem of science teaching in schools both in compartments as well as a whole, and be asked to prepare and submit their final recommendations within one year

without the latter teaching cannot be standardised Indeed, a good textbook can often cover up the dearth of good teachers The methods of teaching should also be organised in a simple and practical manner as far as possible for each grade of students supported by demonstration of simple experiments and practicals Proper and adequate amount of equipment and suitable practical laboratories are the two essential adjuncts of good and effective teaching The system of examination also needs a careful consideration It may not be wise at the initial stage to leave the examination in the hands of the school authorities themselves leading to obvious variation in the standard

It is suggested that the science subjects should be taught in the following sequence

1	*Primary Classes (up to class IV)*	(1) Study of the things around us, in simple descriptive form, to create interest and inquisitiveness (2) Cleanliness and practice of primary rules of health
2	*Upper Primary (up to class VI)*	Beginning of General Science, and of regular Hygiene teaching
3	*Secondary*	(1) General Science dealing with things on and around the earth

		matters—living and inanimate, preliminary basic ideas leading to study of Physics, Chemistry, Biology, etc
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The proportion of children attending Primary schools in India is still a minority and this proportion is steadily reduced at Secondary and High School levels

Little serious thought seems to have been bestowed so far, on science teaching in schools At the primary level elementary science should deal in a general way with natural phenomena familiar every day objects and nature study Much of this can be introduced through language study classes In the Middle and High School stages fundamentals of the major branches of science should be taught with experiments and observation The auxiliary subjects will be Geography, History and Civics Physiology Hygiene and Drawing The teaching in the High School stage should aim at a good standard so that when the students enter technical or vocational schools or the university they will have a good sound background

At present too many individual subjects are taught and too many textbooks prescribed because there has been no logical thinking particularly in regard to the steady improvements of standards in the schools Unsuitable textbooks are prescribed and these are frequently changed

A definite bias can be brought into the High School stage in order to separate out students into groups to fit them into the pattern of further studies they would undertake

Physical Sciences—for those who will take up Science, Technology and Engineering

Biological Sciences—for those taking up Biology, Medicine Agriculture, etc

Humanities and Social Sciences—for those taking up History, Sociology, Philosophy, Law, etc

In the High School there should be a careful separation of the groups who will go in for vocational technical training and those good enough to go to the universities and higher institutions, which otherwise will become increasingly cluttered up by persons of poor calibre leading to national waste and inefficiency

18 K P Chattopadhyay Calcutta

The importance of teaching science in schools in the present age to meet national requirement of trained personnel Teaching of science in schools in England Scotland, Denmark Sweden, France, U S S R and Czechoslovakia as observed by the writer in course of visits to schools in these countries on different occasions The teaching of science in schools in West Bengal The syllabus as framed now for this purpose Suggestions to minimise cost and to improve teaching in the light of the writer s previous experience as Education Officer Calcutta Corporation and his association with High Schools ordinary and multipurpose Difficulties of colleges

In the syllabus of the Secondary Schools up to class X, a subject under the name of General Science is made compulsory to be learnt by every boy and girl This carries 50 marks out of the total of 800 marks prescribed for the School Final Examination as follows —

Total Marks—800	
English	150
Bengali	150
Mathematics	100
Sanskrit	100
History	100
Geography	50
General Science	50
Electives	100
	800

This paper contains topics on four subjects Physics Chemistry Biology and Botany The equipments recommended for such teaching in the classes IX and X cost approximately Rs 2 000/ This is stated to indicate the idea of poor arrangements both in syllabus and equipments prescribed for the teaching of science to every boy and girl coming out of School Final Examination Over and above that due to meagre grade of Rs 70/ to 130/ per month for Science graduates it becomes always a difficult problem

for the Secondary Schools especially in rural areas to secure the services of a science teacher

For learning of Science as an elective subject carrying 100 marks one of the following subjects is prescribed —

Electives of Class X High Schools

(a) Physics, Chemistry
(b) Mechanics
(c) Botany
(d) Biology
(e) Agriculture and Fishiculture
(f) Home nursing and Domestic Science (for girls only)

The equipments prescribed for teaching and laboratory work of Physics, Chemistry, Mechanics cost Rs 5 000 Two periods of Practical work per week in the laboratory of each subject are scheduled for each student Here also I am of the view that the equipments are not adequate Over and above this, services of qualified science teachers are to be secured with great difficulty

Textbooks on regional languages on all the science subjects prescribed, are not yet available,

Higher Secondary Schools (up to class XI)—In this course science subjects are taught to higher standard The equipments cost per subject varies from Rs 25 000/- to 40 000/ according to the subject *In* West Bengal, the School Final Examination of the

Higher Secondary, will begin from 1960 So up till now it is on preparation stage Out of 400 Secondary Schools about 200 Schools are being converted into Higher Secondary till now It will take perhaps another 10/12 years to convert all the schools into Higher Secondary For this conversion, Central and State Governments are paying the cost of buildings and equipments It is reported that for conversion of each school a grant of Rs 1,50,000/ to 2 00 000/ is needed The financial liability for the conversion is undertaken by the Government The main difficulty as arose and anticipated, is the shortage of good science teachers and the textbooks in regional languages As far as I am aware the Expert Committees for Terminology on Mathematics Physics Chemistry and Mechanics, set up by the Ministry of Education, Government of India have not yet completed their work though they have advanced much to achieve their objectives

On completion of their work the regional languages have to look into the terminology and decide how much of it is to be accepted in each regional language and textbooks on science are to be written using that terminology.

1 The textbooks in vernaculars offer a great hindrance to the study of Science in Schools
2 Non availability of Science teachers in adequate number and of proper qualification is another obstacle in the way

3 The financial aspect is at present a third problem, with the exception of the multi purpose schools According to rules of the Board of the Secondary Schools in West Bengal, a school is not allowed to incur expenditure on contingency items including equipments, furniture, books pay of library assistant exceeding 1/3 of the amount spent on account of salary paid to teachers This creates a hindrance for purchase of sufficient equipment for Science teaching

4 No ear marked grant is made for teaching Science subjects

5 Lack of interest on the part of the students to learn Science

1. Schools should be adequately furnished with equipments Finance shall be ear marked for this

2 Arrangement be made for the training of requisite number of Science teachers and an attractive grade be provided for the trained Science teachers

3 Writing of textbooks by properly qualified persons on different Science subjects in each regional language is to be promoted The State Governments are to take adequate measures for this To induce authorities on different subjects to write textbooks, it is necessary to grant award and even financial help

4 Young boys and girls are to be encouraged to take more interest in Science. Separate prizes and awards be granted for study of Science to students by way of recognition of their interest in Science.

5 Special popular lectures especially on the utility of Science in every-day life of people shall be arranged once or twice a year in each school to be delivered to students and teachers by a scientist from nearby Colleges or Research Organisations

20 Bir Bahadur, *Muslim University, Aligarh*

The objectives of science teaching in India need reconsideration in the light of the total educational programme This also calls for re-organisation and re-orientation in administration of science teaching programme as a whole Without such a re-orientation no satisfactory progress appears possible

The complexity of the problem of re organisation of science courses at the secondary level in accordance with the principle of differential psychology, social needs and philosophy of science should not deter us from facing the issue squarely

21 D S Nigam, *Central Institute of Education, Delhi*

The following problems are to be considered :

1. Shortcomings of our teacher preparation:—
Shortcomings are found b[illegible] the subject

matter field as well as in the art of teaching The first may be rectified, besides making the teaching profession more attractive by instituting variety of optional courses in the applications of various branches of Secondary School science in graduation courses and by making specialization in them a desirable qualification for a science teacher's post As for improving the art of teaching, greater attention to systematic conceptual analysis of topics before attempting to teach them should be paid by Teachers' Training colleges Recommendations for instituting M Ed courses in methodology of teaching science with a tentative outline of the course are also made

2 Vitiated interpretation of general science concept —

It is regretable that no attempt has so far been made in this country to evolve a General Science syllabus by adequate procedures as was done by the Science Masters' Association London who first prepared a list of points of contact of a pupil with the scientific aspect of his environment and then evolved a curriculum based on that list Not only should such an attempt be made in this country by a competent body, but demonstration of its technique should be extensively given to teachers and pupils to enable these syllabi to be developed locally in every school and class The technique once learnt, will have an automatic impact on methods of teaching it

3 Failure to share burden with pupils - an impediment to co operative learning —

Children can learn more through supervised

4. Young boys and girls are to be encouraged to take more interest in Science. Separate prizes and awards be granted for study of Science to students by way of recognition of their interest in Science.

5. Special popular lectures especially on the utility of Science in every-day life of people shall be arranged once or twice a year in each school to be delivered to students and teachers by a scientist from nearby Colleges or Research Organisations.

20 Bir Bahadur, *Muslim University, Aligarh*

The objectives of science teaching in India need reconsideration in the light of the total educational programme. This also calls for re-organisation and re-orientation in administration of science teaching programme as a whole Without such a re-orientation no satisfactory progress appears possible.

The complexity of the problem of re organisation of science courses at the secondary level in accordance with the principle of differential psychology, social needs and philosophy of science should not deter us from facing the issue squarely

21 D S Nigam, *Central Institute of Education, Delhi*

The following problems are to be considered

1. *Shortcomings of our teacher preparation*

Shortcomings are found both in the subject

assess these skills, is very much needed Schemes of practical examinations should be prepared on the same lines as various psychological performance tests and they should be standardized after several try outs, and by careful evaluation of their reliability and validity

22 S K Chakrabarty *Calcutta*

The paper starts with an analysis of the development of Secondary education up to the School Leaving stage during the last three decades and deals with the trend of variation of the age group passing out of the School Final Stage which should form an important basis for the preparation of a suitable syllabus The gradual changes in the weightage of Mathematics and Science in the whole syllabus has been analysed It shows that there is a high degree of correlation between the lowering of the age group and the increase in the percentage of failures and the fall in the average standards of education in the country

A comparative study has also been made between the newly introduced Higher Secondary course in the country with similar courses followed in the U S S R and U S A with special emphasis on the following points

(a) School hours devoted to teaching
(b) Weightage of Science allowed
(c) Examination pattern

studies, and hence the teachers can achieve greater results in proportion to their efforts, through these techniques. Their task, will, however, be made much easier if sets of carefully planned assignments and instruction cards for pupils' experiments relating to various courses of studies, are evolved, and made available to them.

4. Why are community resources not utilized?

Use of community resources will always remain a very good aid to teaching. This is, however, likely to be more effective, only if adequate machinery is developed to make use of them. Formation of educational units at these resource centres, for production of literature and for acting as consultants to schools, is suggested.

5. Claims of gifted children

Organization of courses of studies into smaller units and making provision for earning additional credits, over and above the minimum required for a High School Certificate, may be enough to answer the present need. The Science Club approach, rather than segregation—on doubtful criterion—may be a more worthwhile technique of giving guidance to these children.

6. Our haphazard practical examinations

A careful analysis of practical work into the basic skills needed to perform it, and modifying the observational procedure to enable the examiner to

For improvement of science teaching both in schools and colleges we need not only a large number of science teachers but also teachers with good personal qualities combined with suitably high academic qualifications Though the teaching of science to future scientists is a primary consideration, the secondary function of science teaching is to introduce the rising generation of citizens to the principles and methods of science, so that they can at least have an appreciation of science as "an imaginative adventure of the mind seeking truth in the world of mystery , and of the part played by science and technology in the life of the community

Though every opportunity should be taken to represent teaching as a noble and rewarding profession, this in itself, is unlikely to do a great deal to make good the prospective shortage during the peak years of the present decade Many a young scientist especially among those teaching physical and chemical sciences or engineering feels the frustration of being forced into financial sacrifice to remain in the class room when a lucrative industrial or administrative position could be his for the taking

There are several part remedies, which taken together might have an immediate effect on the rate of recruitment Conditions of work could be improved (i) by allowing more time for the preparation of laboratory exercises, (ii) by providing laboratory assistance on a reasonable scale and (iii) by appreciating that science teachers in particular need time for

(d) Teaching methods and external aids to teaching.

The need for prescribing a uniform syllabus with proper emphasis on the different portions and also of *initiating plans for the training* of suitable science teachers have been discussed

The importance of the publication of suitable textbooks and the help and responsibility which the Government and the learned institutions of the country can share has also been discussed.

23. S K. Bhattacharyya, *Indian Institute of Technology Kharagpur*

Some of the main factors which stand in the way of improved science teaching are

(i) shortage of qualified science teachers

(ii) inadequate amount of money available for laboratory assistance and for equipment,

(iii) inadequate number of school laboratories,

(iv) lack of proper training facilities for teachers.

The present and prospective shortage of science teachers constitutes a national problem There is acute shortage of science teachers not only in our country but in the whole world.

our country have practically no science laboratories in the truest sense Adequate funds must be provided by the Government to all the schools for setting up good science laboratories Besides, many of the existing undergraduate colleges have very ill-equipped laboratories and as a result the students coming from those colleges receive very little scientific practical background Liberal funds should be provided to these colleges for upgrading their laboratories

Science teaching can also be improved by (i) organising short-time training course for High School teachers in the universities preferably during a long vacation with the object of bringing the High School teachers up-to-date with the latest developments in their subjects (ii) by introducing overseas teachers' training programme and (iii) by organising lecture programme by eminent scientists in different fields which will no doubt strengthen and stimulate the science programmes in higher schools and colleges and also aid in the motivation of able secondary school students for building up scientific careers

Science teaching can also be improved by organising scientific film shows scientific exhibitions, occasional visits to scientific institutions, workshops and by enhancing the activities of Science Clubs and Societies

Lastly I take this opportunity of reiterating (i) the need for conducting demonstration experiments during class-room teaching and (ii) the need for the

additional study in order to keep abreast of development in their subject (iv) by providing adequate facilities for part-time research particularly to those who are research minded and (v) by encouraging the teachers by awarding prizes medals etc for their meritorious service as teachers and researchers

It is also considered that more senior posts should be created as has been done in the universities to allow greater flexibility in the awarding of allowances and to permit further advancement of gifted teachers without causing them to leave the class room for more remunerative employment elsewhere

A teacher without adequate financial assistance is prevented from giving sufficient time to studying modern developments in his subject(s) and also from undertaking any form of original research His contributions to general out of school activities will also be curtailed

While admitting that the present shortage of teachers, particularly for the secondary schools and the undergraduate colleges is a direct outcome of the over all shortage of fully trained and competent scientists and technologists it is yet true that much could be done to increase the incentives offered to men who feel attracted to teaching but are deterred from it by such considerations as have been outlined above

Except the sponsored high schools and government high schools most of the high schools of

To attain the above objectives, there could be a variety of courses and approaches One such approach is suggested below

A school course for Chemistry must, of necessity, be a basis for further studies in colleges But it should also provide for those who do not intend to prosecute further studies in Chemistry Embracing both these facets a model school course for chemistry is delineated as follows

(A suggested school course for Chemistry with some explanatory notes will be included and discussed in the body of the paper)

The effectiveness of a pattern of teaching of Chemistry and for that matter of any branch of human knowledge must be necessarily bound up with the system of examination and the nature of questions asked After all teaching must have learning as its real goal and an examination must also teach In the context of these, a question paper or a set of questions must have the following in proper balance and proportion —

(a) Questions requiring recall of information

(b) Questions requiring writing of essays, and

(c) Questions requiring solution of problems

(The relative functions and effectiveness of the three types of questions will be elaborated and discussed in the paper)

undergraduate laboratory work in Physics and Chemistry to keep in step with the class room teaching This will improve the effectiveness of the teaching and also lessen the strain on the lecturers and laboratory demonstrators

24 S M Mukherji *Panjab University*

Objectives of high school education underlined, science teaching in the context of these objectives, specialization if any, should be broad based, vocational training at the school stage is antagonistic to the objectives of High School education and therefore should be discouraged a broad pattern of High School course proposed and discussed

Teaching of Chemistry in schools and colleges must have the following objectives

(a) To present the basic principles of Chemistry as an intellectual discipline and as a creative pursuit of human knowledge

(b) to inculcate in the students a habit of analytical and critical thinking involving logical and quantitative relationships

(c) to help the students in acquiring an understanding of the methods of science and of the important part played by Chemistry in every-day life of society and

(d) to develop in the promising students genuine interest in Chemistry for further studies in chemical science

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(The relative functions and effectiveness of the three types of questions will be elaborated and discussed in the paper)

The success of even an ideal course of study will largely depend on the quality of the teachers If the courses of study or syllabi are important it is teaching personnel that is vital Again, no two teachers can be identical in their approach. Therefore, *it is probably high time that there* should evolve a method for selecting from amongst the citizens the right type of persons who can deliver the goods as teachers The shortage of properly *equipped teaching personnel resulting in* the recruitment of those who enter the teaching profession only as the last alternative constitutes the crux of the problem of the crisis in education in our country

A college course for Chemistry *will* be discussed primarily as a basis for those who intend to specialize in science This course will be an extension of the school course for Chemistry

The broad pattern of the questions for examination at the B Sc level should be the same as mentioned earlier for High School examination in Chemistry

25 U P Basu *Bengal Immunity Research Institute, Calcutta*

Scientific pursuit has led to the growth and *diffusion of knowledge for improvement of methods in* enhancing the economic prosperity of a country As science is mostly manifested to the society through industry teaching of science for industry is becoming of considerable significance Science education,

however, is to be integrated from the school to the post-graduate level.

Difficulties were there in the past for the fact that educationists had not tried to understand the requirements of science in industry, nor the industrialists showed any enthusiasm for the development of industry through application of science and technology. Students of science, apart from their special training, must be taught from early stages to learn the intricacies of industry, and the technical workers of the industry must also be given a chance to become intellectuals. This would necessitate a mutual exchange of ideas between teachers of universities and technologists of industries. In such adjustment stress is always to be laid on the understanding of the values of human life.

A closer co-ordination amongst the different agencies (University, State and Industry) would now be essential for proper development of science and technology.

26 A. G. Jhingran, *Geological Survey of India, Calcutta*

In recent years the number of centres with facilities for higher training in Geology has been increased considerably. It is, however, very much regretted that in the syllabus prescribed for the M.Sc. degree of several of these universities adequate emphasis has not been given to the fundamental and basic knowledge in all the branches of Geology, and

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Applied Geology must be given only after the essential basic knowledge has been acquired in all branches of the science The present tendency of running alternative courses in Pure and Applied Geology after a most rudimentary B Sc course is not sound How can applied knowledge be given unless the basic knowledge in pure science has been acquired It appears to the present writer that the best course for education in Applied Geology would be to have two-year orthodox course in Geology leading to the M Sc degree followed by a one year course with emphasis on Applied Geology It is suggested that some Central authority should step in and initiate standardisation of courses in all the different universities at least so far as Geology is concerned Possibly the Inter University Board aided by the Ministry of Education could organise a machinery to look into this and take concrete steps The National Institute could lend its weight in establishing a proper machinery

Another point of vital importance in connection with the education in Geology is the recognition of the fact that Geology is essentially a field science It will therefore be of mutual benefit to have greater co-operation between the different departments of the government that are devoted to field studies and the universities where academic and laboratory work finds greater emphasis Recently a number of schemes have been introduced under which the students of universities are being granted facilities for experience and training in field work in the Geological Survey of

they are thus what may be described as "unbalanced". In some cases Indian Stratigraphy does not find a proper treatment, in others Palaeontology is badly neglected, in still other fields, Geology is more or less completely ignored. As a result of this the boys trained in these centres are not equipped with knowledge of an all-round nature and they are unable to give a satisfactory account of themselves for no fault of their own. It is, therefore, urgently called for that steps be taken for standardisation of courses leading to the post-graduate degree and that any wide disparity that may be existing in the syllabus of the different universities and institutions should be removed

An additional problem that has recently cropped up in this connection is through the zeal of certain universities to lay greater emphasis on applied aspects of Geology which has led them to start courses leading to an M.Sc. degree or diploma in Applied Geology. This new name has a greater appeal and it catches the imagination of at least some of the employers It is, however, a matter of doubt that at what stage the emphasis on Applied Geology should be laid. The present writer is definitely of the opinion that basic education in the numerous and diverse branches of Geology including Dynamic and General Geology, Crystallography and Mineralogy, Petrology, Ore genesis and Economic Geology, Palaeontology and Palaeobotany, Principles of Stratigraphy, Field Geology, etc. is very essential and any emphasis on

Applied Geology must be given only after the essential basic knowledge has been acquired in all branches of the science. The present tendency of running alternative courses in Pure and Applied Geology after a most rudimentary B.Sc. course is not sound. How can applied knowledge be given unless the basic knowledge in pure science has been acquired. It appears to the present writer that the best course for education in Applied Geology would be to have two-year orthodox course in Geology leading to the M Sc. degree, followed by a one-year course with emphasis on Applied Geology It is suggested that some Central authority should step in and initiate standardisation of courses in all the different universities at least so far as Geology is concerned. Possibly the Inter-University Board aided by the Ministry of Education could organise a machinery to look into this and take concrete steps The National Institute could lend its weight in establishing a proper machinery.

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India. This is indeed very welcome. It, however, needs to be further intensified. In addition, it is suggested that a system of interchange between the field officers of government departments and the teachers of the universities for a suitable period, say one year or two in each case, be introduced

27 S Deb, *Jadavpur University, Calcutta*

In the curriculum of science teaching in the Secondary Schools, a very elementary idea is given in the treatment of natural phenomena such as atmosphere, water as a vital need of life, earth's surface—including the study of rocks and minerals In most of the schools, this portion is not at all touched in the class as most of the schools do not possess the apparatus, rocks and mineral samples for demonstration

Due to the growing demand of geologists in the country, and also due to the increased opportunities of getting admission in geological sciences at the university stage, Geology should be introduced as an elective subject in the science stream of the secondary schools in the same manner as Biology, Mechanics Special Mathematics, etc. etc. Moreover, the subject of Geography which is at present included in the humanities stream as well as in the science stream has the same syllabus and has the same line of approach in the method of teaching. A different method of treatment in teaching Geography in the two different streams should be adapted, e.g. more of human geography and

cultural land scape and Regional Geography and Commercial Geography in humanities stream and a heavier dose of Physical Geography, Geomorphology, economic minerals of India and other countries, Regional Geography of South East Asia and Middle East countries etc etc should be included in the Geography course the science stream No separate arrangements are necessary at present for teaching Geology as an elective subject in the schools except a slight addition and alteration of the existing Geography laboratory and the same teacher who is teaching Geography, will be able to teach the major part of the course The Science Clubs can make arrangements to offer assistance to the schools in extending science lecture programme with lantern slides and film strips

In the General Certificate of Education Examination of London University, Geology is included at all levels, i e ordinary advanced and scholarship levels. In France Geology is included as compulsory subject in the baccalaureat examination in the second cycle of science stream In most of Lycees and Colleges, the geographical teaching arrangements are broadened to include all the different aspects of teaching Geology in baccalaureat standard

In W Germany, the Reife Prufung or Abitur examination, contains a very heavy course of Physical Geography in which almost all the important branches of Earth's sciences are taught

The All India Council for Secondary Education

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water—Broad outlines of immunization—Later on communicable diseases—What to do in case of epidemics or in epidemic area—Seeking help of local health authorities

Mental Hygiene course in consultation with psychiatrists—More stress on emotional condition and social behaviour under overcrowded conditions and increased tempo of life—Sex hygiene and sex education within limits—Broad facts about child birth and protection against sexual offences specially for girls

Ideal teachers—People experienced in public health practice—Medical graduates with theoretical training of hygiene not suited—Non medical teachers properly trained preferable

29 B C Kundu *Barrackpore*

The basic need for successful teaching of any scientific subject is the aptitude of the student for learning the subject which largely depends on the method of teaching Paucity of trained teachers and shortage of space and equipment seem to be the reasons for failure of a realistic approach towards the teaching of a scientific subject like Botany

There is an acute shortage of properly qualified science teachers in our country and as a result young boys and girls who are anxious to take up the study of science do not find science sufficiently interesting The need for trained graduate (B Sc and M Sc) scientists

should consider this matter carefully before finalising the curriculum of science teaching in our Secondary Schools.

28 K. Mitra, *Calcutta*

Teaching of Hygiene can be conveniently discussed under syllabus and teachers—Existing syllabus needs material amendment, concept of positive health—Subject no longer confined to personal hygiene and communicable diseases—Bias on physical fitness, mental fitness and social fitness—Development of *proper attitude towards the subject—Hygiene broadly* differs from other disciplines as it is applicable to the organism itself.

Teaching in earlier standards Oral lectures on fundamentals—Allocation of marks on actual practice—Personal Hygiene keystone at this stage—Specific diseases be better excluded At school premises environmental sanitation to be ensured—Emphasis on pure and wholesome water supply and also safe disposal of sewage—Disposal of bodily excreta—Next stage, stress on relationship of food and physique—Special needs for the growing period -More in terms of actual items of food than discussion of proximate principles—Physical exercise dependent on intake of food—School meals—Uninteresting details about soil, hardness of water, ventilation (Tobins tube, Sherringham valves etc.) be better excluded—Less details about sources of water supply—More on how to ensure drinking of safe

The M Sc degree in different Indian universities is obtained by submitting a thesis only or by a thesis and some papers The submission of a thesis in the M Sc course leads to specialisation in fundamental aspects of the subject with a neglect on the part of the student of other important branches M Sc 's who get their degree by thesis are not likely to become good teachers due to the lack of detailed knowledge of other branches besides the subject of their thesis

There is another serious lacuna in the curriculum of Botany in the M Sc courses of our universities, viz, the neglect of applied sides of the subject As for example the subject of plant breeding and genetics is not usually given as much stress in our universities as should be given

Botany teaching is to be planned with relation to agriculture horticulture and other requirements of human society The whole object is to arouse an interest in the student for learning the subject

Re-orientation of Botany courses on the broad suggestions outlined above will help in building proper personnel required in the spheres of botanical teaching and in the fields of agriculture as a whole

30 S K. Chakrabarty *Calcutta*

The paper gives a comparative review of the Higher Technological Courses followed in the U S A, U S S R and India with special reference to the

for teaching science in the secondary schools and colleges is always there, but as the pay in secondary schools and colleges is not quite attractive, the graduate scientists go in for better paid jobs in other lines which they find more lucrative.

Science has now been introduced as a compulsory subject in the curricula of secondary schools. It is, therefore, all the more necessary to make the subject as interesting as possible to the young learners. An introductory course in Botany can be really interesting if it covers some of the social applications of Botany.

The interesting subject of plants is faced by the beginners with an amount of awe due to the introduction of a large number of technical terms from the very outset. For creating an interest in the minds of the young learners about the subject of study the manner of treatment has to be made more attractive by introducing plants specimens to the learners from the very beginning, holding practical demonstrations of interesting phenomena of plant life and by giving more stress to field work.

The subject of Botany as now taught in the colleges and the universities is based on old English courses. With the progress of time it has now become imperative to reorientate the courses in order to make them more attractive to the beginners and include the economic aspects of Botany in the higher courses.

In the universities more emphasis is given to research in our courses of study for the M.Sc. degree.

weightage given to basic sciences The extent of Mathematics and Physics which the future engineers must know in order to cope with the proper industrial development of the country has been analysed It has been suggested that in addition to allowing more stress on basic sciences in the present undergraduate courses, a post graduate course in Engineering Science should be developed, which can be taken up by a student of pure science after his M Sc course, and also by a scientifically biased engineer after the completion of his graduate course *This group will then be able to develop into proper design or research engineers* The lack of suitable men for teaching posts in the higher technological institutes can then be satisfactorily faced with advantage The paper also discusses the need for a common syllabus for the different institutions of equivalent standard at least up to the undergraduate level and also the need for a central body for the assessment of the standards of teaching and examination followed in the different institutions It has been shown how without the incorporation of a proper amount of basic sciences in the syllabus, the higher technological education in the country will become stale and uninteresting